# TIME-MATCHING SYSTEM AND TIME-MATCHING METHOD

## Background of the Invention

### 1. Field of the Invention

5        The present invention relates to a time-matching system and a time-matching method, in particular, to a time-matching system and a time-matching method for wireless communication terminal devices.

10   ### 2. Description of the Related Art

In a computer network, time-data can be obtained by connecting to an NTP (Network Time Protocol) server. Also, a mobile GPS (Global Positioning System) receiver can obtain time-data from a GPS satellite

15   which provides the time-data (referred to as satellite time-data) as well as position-data.  Such satellite time-data has higher accuracy than time-data provided by an NTP server.  A terminal device with a GPS receiver (or a terminal device connected to a GPS

20   receiver) can obtain satellite time-data, and hence a clock within the terminal device can be calibrated by reference to the satellite time-data.  However, the satellite time-data can not be shared between the terminal device and terminal devices with no GPS

25   receiver (or terminal devices not connected to a GPS receiver).

A technology is desired, with which time-data

with high accuracy can be shared between a terminal device having the time-data and other terminal devices on a wireless communication network (for example, a wireless Local Area Network).

5      Japanese Laid Open Patent Application (JP-P-Heisei 10-145845) discloses a mobile communication system. The mobile communication system includes a plurality of base stations, each of which has a GPS receiver. Time-data included in GPS-data received by

10   the GPS receiver is delayed to generate a delayed timing signal. Each base station synchronizes a call signal from a mobile communication device with the delayed timing signal. Therefore, the synchronization between the plurality of base stations is achieved

15   without presetting the amount of time-delay for each base station.

Japanese Laid Open Patent Application (JP-P2000-278746A) discloses a communication system. According to the communication system, a communication device

20   receives a GPS synchronization signal from a CDMA (Code Division Multiple Access) network, and transmits a synchronization signal to a PHS (Personal Handy-phone System) network in synchronization with the GPS synchronization signal. Then, the system clock in the

25   PHS network is corrected based on the received synchronization signal.

Japanese Laid Open Patent Application (JP-P2002-

156477A) discloses a time correcting system. The time correcting system connected to a network includes a communication device having a receiving unit and a transmitting unit. Here, the receiving unit receives

5    time-data to which a reliability parameter is added. The communication device generates new time-data by adding a reliability parameter of its own to the received time-data having the reliability parameter. Then, the communication device transmits the new time-

10    data via the above-mentioned network.

The communication device further includes a time generating unit, a time-data extracting unit, a time-data comparing unit and a time correcting unit. The time generating unit generates own time-data. The

15    time-data extracting unit extracts time-data having a reliability parameter from the data received by the receiving unit. The time-data comparing unit compares the own time-data generated by the time generating unit with the time-data having the reliability

20    parameter extracted by the time-data extracting unit. The time correcting unit controls the time generating unit based on the result of comparison provided by the time-data comparing unit.

An object of the time correcting system mentioned

25    above is to adjust automatically the clock build in each communication device on the network without concentrating the load on a certain communication

device.

Japanese Laid Open Patent Application (JP-P2000-314771A) discloses a GPS-based information system. The GPS-based information system is composed of a plurality of GPS-based information transmitting stations and a plurality of information receiving terminals. Each of the plurality of GPS-based information transmitting stations includes a GPS antenna, a GPS receiver and a transmitter.

The GPS antenna receives radio waves from GPS satellites. The GPS receiver receives GPS-data from the GPS antenna and outputs position-data and time-data to the transmitter. The transmitter transmits the position-data and the time-data to the plurality of information receiving terminals.

An object of the GPS-based information system mentioned above is to reduce the electrical power consumption of each terminal by reducing the amount of calculation for detecting its location. Another object is to manage the users' security and locations by utilizing the wireless LAN communication.

## Summary of the Invention

Therefore, an object of the present invention is to provide a time-matching system and a time-matching method with which a time-data with high accuracy in a certain terminal device can be shared with other

terminal devices on a wireless communication network.

Another object of the present invention is to provide a time-matching system and a time-matching method with which a time-data with high accuracy

5 provided by GPS satellites can be shared between a plurality of terminal devices on a wireless communication network.

Still another object of the present invention is to provide a time-matching system and a time-matching

10 method which can automatically correct clocks of a plurality of terminal devices on a wireless communication network.

Still another object of the present invention is to provide a time-matching system and a time-matching

15 method with which each of a plurality of terminal devices can make its own clock accurate enough to be consistent with satellite time-data from GPS satellites without using a GPS receiver.

In an aspect of the present invention, a time-

20 matching system includes a first terminal device capable of receiving a GPS (Global Positioning System) data from a GPS satellite and a communications relay device relaying communications between the first terminal device and a second terminal device on a

25 wireless communications network.

The first terminal device executes a first correction procedure on a satellite time-data in the

GPS data to generate a first time-data, and transmits the first time-data to the communications relay device. The first correction procedure is executed based on a time delay in communications between the GPS satellite

5 and the first terminal device. Also, the first terminal device adds to the first time-data a priority-data indicative of reliability of the first time-data in the first correction procedure.

The communications relay device receives the

10 first time-data, executes an intermediate correction procedure on the first time-data to generate an intermediate time-data, and transmits the intermediate time-data to the second terminal device. The intermediate correction procedure is executed based on

15 a time delay in communications between the first terminal device and the communications relay device. Also, the communications relay device adds to the intermediate time-data the priority-data in the intermediate correction procedure.

20 The communications relay device determines whether the reception of the first time-data is permitted or not based on an address of the first terminal device. Also, the communications relay device determines whether the intermediate correction

25 procedure is permitted or not based on the priority-data.

The second terminal device receives the
intermediate time-data, determines whether a second
correction procedure is permitted or not based on the
priority-data, executes the second correction
5 procedure on the intermediate time-data to generate a
second time-data.  The second correction procedure is
executed based on a time delay in communications
between the communications relay device and the second
terminal device.  Then, the second terminal calibrates
10 a clock of the second terminal device based on the
second time-data.

In another aspect of the present invention, a
first terminal device includes a GPS receiver and a
data processing device.  The GPS receiver receives a
15 GPS-data from a GPS satellite and outputs the GPS-data
to the data processing device.  The data processing
device is connected to the GPS receiver and receives
the GPS-data.

The data processing device extracts a satellite
20 time-data from the GPS-data, executes a first
correction procedure on the satellite time-data to
generate a corrected time-data (a first time-data).
The correction procedure is executed based on a time
delay in communications between the GPS satellite and
25 the GPS receiver.  The data processing device adds to
the first time-data a priority-data indicative of
reliability of the first time-data, and transmits the

first time-data to a destination on a wireless
communication network.

A communications relay device relays wireless
communications between the first terminal device and a
5    second terminal device. The communications relay
device includes a priority comparing unit, a delay
calculating unit, a clock, and a time setting unit.

The priority comparing unit determines whether
reception of the first time-data is permitted or not
10   based on an address of the first terminal device.
Then, the priority comparing unit receives the first
time-data from the first terminal device and permits
an intermediate correction procedure on the first
time-data based on the priority-data. The delay
15   calculating unit executes the intermediate correction
procedure on the first time-data to generate an
intermediate time-data. The intermediate correction
procedure is executed based on a time delay in
communications between the first terminal device and
20   the delay calculating unit. The time setting unit
calibrates the clock based on the intermediate time-
data. The intermediate time-data is transmitted to
the second terminal device.

The second terminal device includes a priority
25   comparing unit, a delay calculating unit, a clock, and
a time setting unit. The priority comparing unit
receives the intermediate time-data from the wireless

communications relay device and permits a second
correction procedure on the intermediate time-data
based on the priority-data. The delay calculating
unit executes the second correction procedure on the
5 intermediate time-data to generate a corrected time-
data (second time-data). The correction procedure is
executed based on a time delay in communications
between the wireless communications relay device and
the delay calculating unit. The time setting unit
10 calibrates the clock based on the second time-data.

In still another aspect of the present invention,
a time-matching method includes the steps of: (a) a
first terminal device generating a first time-data by
executing a first correction procedure on a satellite
15 time-data received from a GPS satellite, the first
correction procedure being based on a time delay in
communications between the GPS-satellite and the first
terminal device; (b) the first terminal device
calibrating a clock of the first terminal device based
20 on the first time-data; (c) the first terminal device
transmitting the first time-data wirelessly to a
communications relay device; (d) the communications
relay device receiving the first time-data and
generating an intermediate time-data by executing an
25 intermediate correction procedure on the first time-
data, the intermediate correction procedure being
based on a time delay in communications between the

first terminal device and the communications relay device; and (e) the communications relay device transmitting the intermediate time-data to a second terminal device different from the first terminal device.

The (a) generating step includes (a1) adding to the first time-data a priority-data indicative of reliability of the first time-data in the first correction procedure. The (d) receiving and executing step includes: (d1) the communications relay device determining whether reception of the first time-data is permitted or not based on an address of the first terminal device; and (d2) the communications relay device determining whether the intermediate correction procedure is permitted or not based on the priority-data.

The time-matching method further includes: (f) the second terminal device receiving the intermediate time-data and generating a second time-data by executing a second correction procedure on the intermediate time-data, the second correction procedure being based on a time delay in communications between the communications relay device and the second terminal device; and (g) the second terminal device calibrating a clock of the second terminal device based on the second time-data. The (f) generating step includes (f1) determining whether

the second correction procedure is permitted or not based on the priority-data.

It should be noted that the order of the steps in the above-mentioned time-matching method can be changed to the extent that consistency is maintained.

According to the present invention, as described above, a time-data with high accuracy provided by GPS satellites can be shared between a plurality of wireless terminal devices on a wireless communication network. Also, a user of a wireless terminal device without a GPS receiver can correct the clock of the own wireless terminal device by receiving time-data from a user of a wireless terminal device having a GPS receiver without mounting a GPS receiver on the own wireless LAN terminal device. Thus, the clocks of the plurality of wireless terminal devices on a wireless communication network can be corrected automatically.


**Brief Description of the Drawings**

Fig. 1 shows a configuration of a time-matching system according to an embodiment of the present invention;

Fig. 2 shows contents of the MAC table; and

Fig. 3 is a flow chart showing a time-matching method according to the time-matching system of the present invention.

## Description of the Preferred Embodiments

Embodiments of the present invention will be described below with reference to the attached drawings. A time-matching system according to the present invention utilizes a wireless network. A wireless LAN (Local Area Network) exemplifies the wireless network.

Fig. 1 shows a configuration of a time-matching system according to the embodiment of the present invention. A time-matching system 1 includes a GPS-based terminal device 10 and a plurality of wireless LAN (WLAN; Wireless Local Area Network) access points 16-i (i is an integer more than or equal to 1 and less than or equal to n, wherein n is a number of the wireless LAN access points). The GPS-based terminal device 10 and each of the plurality of wireless LAN access points 16-i are connected with each other via a wireless LAN (WLAN) link 23 to establish two-way communication.

Each of the plurality of wireless LAN access points 16-i is connected to a plurality of wireless LAN (WLAN) terminal devices 17-j (j is an integer more than or equal to 1 and less than or equal to $m_i$, wherein $m_i$ is a number of the wireless LAN terminal devices connected to a wireless LAN access point 16-i) via a wireless LAN link 24 to establish two-way communication.

Each of the wireless LAN links 23, 24 constructs a Local Area Network without cable lines by using radio waves and infrared to establish wireless communication. The wireless LAN link 23 and the wireless LAN link 24 may construct an identical Local Area Network. It should be noted that the network in the present invention can be a network other than a LAN.

A GPS (Global Positioning System) satellite 11 transmits data including time-data and position-data by radio waves. The data and the time-data provided by the GPS satellite 11 are referred to as a GPS-data 31 and a satellite time-data 32, respectively. The time-matching system 1 is capable of receiving the GPS-data 31 from the GPS satellite 11 via a satellite link 21.

The GPS-based terminal device (first terminal device) 10 has a GPS receiver 12 and a wireless LAN terminal device 14. The GPS receiver 12 detects the radio waves transmitted by the GPS satellite 11, and outputs the GPS-data 31 including the satellite time-data 32 to the wireless LAN terminal device 14. The wireless LAN terminal device 14 executes a first correction procedure on the satellite time-data 32 to generate a first time-data 33. Also, the wireless LAN terminal device 14 calibrates its own clock based on the first time-data 33.

More specifically, the GPS receiver 12 has a GPS receiver module 49 and a GPS antenna 50. The GPS receiver module 49 detects the radio waves from the GPS satellite 11 by using the GPS antenna 50. Next,

5    the GPS receiver module 49 extracts the GPS-data 31 from the detected radio waves. Then, the GPS receiver module 49 outputs the GPS-data 31 including the satellite time-data 32 to the wireless LAN terminal device 14 through an internal line 22. The GPS

10   receiver 12 may be built in the GPS-based terminal device 10 or may be configured to be detachable to the GPS-based terminal device 10. Also, the GPS receiver 12 may be mobile and connected to the wireless LAN terminal device 14 via a communication cable.

15       The wireless LAN terminal device 14 is a data processing device such as a personal computer. The wireless LAN terminal device 14 includes a time calculating unit 41, a delay calculating unit 42, a time setting unit 43, a clock 45, a data storage 46, a

20   wireless LAN adapter 47 and a GPS adapter 48. Here, the wireless LAN terminal device 14 can be provided specially as a device for obtaining the satellite time-data 32. Alternatively, the wireless LAN terminal device 14 can be in the same position as an

25   after-mentioned wireless LAN terminal device 17-j on the network except that the wireless LAN terminal device 14 is connected to the GPS receiver 12.

The GPS adapter 48 receives the GPS-data 31 including the satellite time-data 32 from the GPS receiver 12.

The clock 45 is a clock in the wireless LAN terminal device 14.

The delay calculating unit 42 calculates delay time by using a conventional method, and executes a first correction procedure on the satellite time-data 32 based on the calculated delay time to generate a first time-data 33.

The data storage 46 includes a memory unit and stores the GPS-data 31, the first time-data 33 and data of time when the wireless LAN terminal device 14 has received the GPS-data 31 which is determined by the clock 45.

The time calculating unit 41 adds a priority-data to the first time-data 33. Here, the priority-data is defined as an indicator of reliability, i.e., is representative of the source of a time-data. For example, when a time-data is based on the satellite time-data 32, which is most accurate, the priority-data has a value of "1". When a time-data is provided by an NTP (Network Time Protocol) server, which is second most accurate, the priority-data has a value of "2". In the other cases, the priority-data has a value of "3". In the case of the above-mentioned time calculating unit 41, the priority-data of "1" is given

to the first time-data 33. An after-mentioned
wireless LAN terminal device 17-j may have time-data
including priority-data of other than "1".

The time setting unit 43 calibrates the clock 45
5    based on the first time-data 33, i.e., sets current
time-data to the first time-data 33.

The wireless LAN adapter 47 transmits the first
time-data 33 to every one of the plurality of wireless
LAN access points 16-i via the wireless LAN link 23.

10        The first correction procedure executed by the
delay calculating unit 42 includes (a) calculating the
time which the GPS-data 31 has taken to travel between
the GPS satellite 11 and the GPS-based terminal device
10 and (b) adding the calculated time (referred to as
15    a delay time $\Delta T1$, hereinafter) to the satellite time-
data 32. Thus, the first time-data 33 is generated.
It should be noted that if time necessary for
processing and transmitting the GPS-data 31 in the
GPS-based terminal device 10 is not negligible, such
20    time is also added to the delay time $\Delta T1$ (the
satellite time-data 32). The delay time $\Delta T1$ is
calculated by using a conventional delay calculating
circuit.

Each of the plurality of the wireless LAN access
25    points 16-i is a communications relay station by which
communication is relayed on the Local Area Network.
Each wireless LAN access point 16-i receives the first

time-data 33 from the GPS-based terminal device 10,
adjusts the first-time data 33 to generate an
intermediate time-data 34 and transmits the
intermediate time-data 34 to a device different from
5    the GPS-based terminal device.  Each wireless LAN
access point 16-i has a delay calculating unit 52, a
time setting unit 53, a priority comparing unit 54, a
clock 55, a data storage 56 and a MAC (Media Access
Control) table 36.

10       The clock 55 is a clock of the wireless LAN
access point 16-i and generates time-data.  Also, the
clock 55 has a priority-data of the time-data of the
wireless LAN access point 16-i.

        The MAC table 36 contains address data (MAC
15   addresses) of the wireless LAN adapters 47 of terminal
devices (including the GPS-based terminal device 10),
each of which is associated with information whether
the reception of the first time-data 33 from that MAC
address is permitted or not.

20       The priority comparing unit 54 receives an
address data (MAC address) of the wireless LAN adapter
47 of the GPS-based terminal device 10.  Based on the
MAC address, the priority comparing unit 54 determines
whether the reception of the first time-data 33 from
25   the GPS-based terminal device 10 is permitted or not
by referring to the MAC table 36.  When the reception
is permitted, the priority comparing unit 54 compares

the priority-data of the first time-data 33 with a priority-data which the clock 55 of the wireless LAN access point 16-i has. If the reliability of the first time-data 33 is equal to or higher than the

5    reliability of the time-data of the clock 55, the priority comparing unit 54 permits an intermediate correction procedure on the first time-data 33.

      The delay calculating unit 52 includes a conventional delay calculating circuit. When the

10   intermediate correction procedure is permitted by the priority comparing unit 54, the delay calculating unit 52 executes the intermediate correction procedure on the first time-data 33 to generate the intermediate time-data 34.

15      The time setting unit 53 calibrates the clock 55 based on the intermediate time-data 34, i.e., sets current time-data to the intermediate time-data 34. Also, the time setting unit 53 updates the priority-data of the clock 55.

20      The data storage 56 includes a memory unit and stores the first time-data 33, the intermediate time-data 34 and the like. The intermediate time-data 34 is transmitted to each destination in every communication through the wireless LAN access point

25   16-i.

      The intermediate correction procedure executed by the wireless LAN access point 16-i includes (a)

calculating the time which the first time-data 33 has taken to travel between the GPS-based terminal device 10 and the wireless LAN access point 16-i on the wireless LAN link 23 and (b) adding the calculated

5　time (referred to as a delay time $\Delta T2$, hereinafter) to the first time-data 33. Thus, the intermediate time-data 34 is generated. It should be noted that if time necessary for processing and transmitting the first time-data 33 in the wireless LAN access point 16-i is

10　not negligible, such time is also added to the delay time $\Delta T2$ (the first time-data 33). The delay time $\Delta T2$ is calculated by using a conventional delay calculating circuit.

　　The GPS-based terminal device 10 (first terminal

15　device) is connected to each of the plurality of wireless LAN terminal devices 17-j (second terminal device) via the wireless LAN network. Each wireless LAN terminal device 17-j (second terminal device) is a data processing device such as a personal computer.

20　The wireless LAN terminal device 17-j communicates with the corresponding one of the plurality of wireless LAN access points 16-i wirelessly, and receives the intermediate time-data 34 from that wireless LAN access point 16-i. The wireless LAN

25　terminal device 17-j includes a delay calculating unit 62, a time setting unit 63, a priority comparing unit 64 and a clock 65.

The clock 65 is a clock of the wireless LAN terminal device 17-j and generates time-data. Also, the clock 65 has a priority-data of the time-data of the wireless LAN terminal device 17-j.

5      The priority comparing unit 64 compares the priority-data of the intermediate time-data 34 from the wireless LAN access point 16-i with a priority-data which the clock 65 of the wireless LAN terminal device 17-j has. If the reliability of the

10  intermediate time-data 34 is equal to or higher than the reliability of the time-data of the clock 65, the priority comparing unit 64 permits a second correction procedure on the intermediate time-data 34.

The delay calculating unit 62 includes a

15  conventional delay calculating circuit. When the second correction procedure is permitted by the priority comparing unit 64, the delay calculating unit 62 executes the second correction procedure on the intermediate time-data 34 to generate a second time-

20  data 35.

The time setting unit 63 calibrates the clock 65 based on the second time-data 35, i.e., sets current time-data to the second time-data 35. Also, the time setting unit 63 updates the priority-data of the clock

25  65.

The second correction procedure executed by the wireless LAN terminal device 17-j includes (a)

calculating the time which the intermediate time-data

34 has taken to travel between the wireless LAN access

point 16-i and the wireless LAN terminal device 17-j

on the wireless LAN link 24 and (b) adding the

5    calculated time (referred to as a delay time $\Delta T3$,

hereinafter) to the intermediate time-data 34. Thus,

the second time-data 35 is generated. It should be

noted that if time necessary for processing and

transmitting the intermediate time-data 34 in the

10   wireless LAN terminal device 17-j is not negligible,

such time is also added to the delay time $\Delta T3$ (the

intermediate time-data 34). The delay time $\Delta T3$ is

calculated by using a conventional delay calculating

circuit.

15       Fig.2 shows contents of the MAC table 36. The

MAC table 36 contains MAC addresses of the wireless

LAN adapters 47 of terminal devices (including the

GPS-based terminal device 10), each of which is

associated with information whether the reception of

20   the first time-data 33 from that MAC address is

permitted or not. The column 36-2 contains MAC

addresses of the wireless LAN adapters 47 of the

terminal devices. The column 36-1 indicates whether

the reception of the first time-data 33 from the

25   corresponding MAC address is "permitted" or

"forbidden".

Next, a time-matching method according to the

time-matching system of the present invention will be
described below.  Fig. 3 is a flow chart showing the
time-matching method according to the present
embodiment.

5        (1) Step S01

        The radio waves transmitted by the GPS satellite
11 is received by the GPS receiver module 49 of the
GPS-based terminal device (first terminal device) 10
through the GPS antenna 50 periodically with an
10  appropriate time interval.  Then, the GPS-data 31
including the satellite time-data 32 is extracted from
the radio waves.  The extracted GPS-data 31 is
supplied to the wireless LAN (WLAN) terminal device 14
of the GPS-based terminal device 10 via the internal
15  line 22.

        (2) Step S02

        The satellite time-data 32 is received by the
wireless LAN terminal device 14 through the GPS
adapter 48.  The wireless LAN terminal device 14
20  executes the first correction procedure on the
satellite time-data 32 to generate the first time-data
33.

        (3) Step S03

        The wireless LAN terminal device 14 adds the
25  priority-data to the first time-data 33.

        (4) Step S04

        The wireless LAN terminal device 14 calibrates

the clock 45 based on the first time-data 33, i.e.,
sets current time-data to the first time-data 33.

(5) Step S05

The wireless LAN terminal device 14 establishes a
connection to a wireless LAN (WLAN) access point 16-i
via the wireless LAN link 23 by using the wireless LAN
adapter 47.  When or after the connection is
established, the first time-data 33 with the priority-
data is transmitted to the wireless LAN access point
16-i together with data transferred according to a
wireless communication protocol.

(6) Step S06

The wireless LAN access point 16-i extracts the
address-data (MAC address) of the GPS-based terminal
device 10 from the first time-data 33 and the data
transferred according to the wireless communication
protocol.

(7) Step S07

The MAC address is checked by referring to the
MAC table 36 in the wireless LAN access point 16-i.
If the MAC address is included in the row "permitted"
in the MAC table 36, the reception of the first time-
data 33 is permitted.  If the MAC address is included
in the row "forbidden" in the MAC table 36, the
communication process ends.

(8) Step S08

If the reception of the first time-data 33 is

permitted, the wireless LAN access point 16-i extracts

a priority-data from the first time-data 33.

(9) Step S09

The wireless LAN access point 16-i compares the

priority-data of the first time-data 33 with a

priority-data which the clock 55 of the wireless LAN

access point 16-i has. If the reliability of the

first time-data 33 is equal to or higher than the

reliability of the time-data of the clock 55, the

intermediate correction procedure on the first time-

data 33 is permitted. Otherwise, the intermediate

correction procedure is not permitted, and the

communication process ends.

(10) Step S10

The wireless LAN access point 16-i executes the

intermediate correction procedure on the first time-

data 33 to generate the intermediate time-data 34.

(11) Step S11

The wireless LAN access point 16-i calibrates the

clock 55 based on the intermediate time-data 34, i.e.,

sets current time-data to the intermediate time-data

34. Also, the priority-data of the clock 55 is

updated.

(12) Step S12

The wireless LAN access point 16-i establishes a

connection to a wireless LAN (WLAN) terminal device

17-j via the wireless LAN link 24 for delivering the

intermediate time-data 34 to the wireless LAN terminal device 17-j periodically with an appropriate time interval. When or after the connection is established, the intermediate time-data 34 with the priority-data

5   is transmitted to the wireless LAN terminal device 17-j together with data transferred according to the wireless communication protocol.

Or, the wireless LAN terminal device 17-j establishes a connection to a wireless LAN access

10  point 16-i via the wireless LAN link 24. When or after the connection is established, the intermediate time-data 34 with the priority-data is transmitted to the wireless LAN terminal device 17-j together with data transferred according to a wireless communication

15  protocol.

(13) Step S13

The wireless LAN terminal device 17-j receives the intermediate time-data 34, and extracts a priority-data from the intermediate time-data 34.

20       (14) Step S14

The wireless LAN terminal device 17-j compares the priority-data of the intermediate time-data 34 with a priority-data which the clock 65 of the wireless LAN terminal device 17-j has. If the

25  reliability of the intermediate time-data 34 is equal to or higher than the reliability of the time-data of the clock 65, the second correction procedure on the

intermediate time-data 34 is permitted. Otherwise, the second correction procedure is not permitted, and the communication process ends.

(15) Step S15

5      The wireless LAN terminal device 17-j executes the second correction procedure on the intermediate time-data 34 to generate the second time-data 35.

(16) Step S16

The wireless LAN terminal device 17-j calibrates

10     the clock 65 based on the second time-data 35, i.e., sets current time-data to the second time-data 35. Also, the priority-data of the clock 65 is updated.

According to the Steps S01 to S16 mentioned above, it becomes possible to share highly accurate time-data

15     with the plurality of wireless LAN access points 16-i and the plurality of wireless LAN terminal devices 17-j over the wireless LAN network. Here, the highly accurate time-data is obtained by a terminal device (GPS-based terminal device 10) which has a GPS

20     receiver and is capable of receiving satellite time-data from GPS satellites.

In the Step S05 mentioned above, the plurality of the wireless LAN access points 16-i includes all wireless LAN access points over the wireless LAN

25     network. Therefore, a wireless LAN access point 16-i without a GPS receiver can obtain time-data from a user of a wireless LAN terminal device with a GPS

receiver.  Thus, the wireless LAN access point 16-i
can correct the time-data of the plurality of wireless
LAN terminal devices 17-j connected to the wireless
LAN access point 16-i.  It should be noted that the
5  plurality of the wireless LAN access points 16-i can
be limited to a part of the wireless LAN access points
over the wireless LAN network.

In the Step S12 mentioned above, the plurality of
the wireless LAN terminal devices 17-j includes all
10  wireless LAN terminal devices over the wireless LAN
network.  Therefore, a user of a wireless LAN terminal
device without a GPS receiver can obtain time-data
from a user of a wireless LAN terminal device with a
GPS receiver, and can correct the time-data of a
15  wireless LAN terminal device 17-j.  It should be noted
that the plurality of the wireless LAN terminal
devices 17-j can be limited to a part of the wireless
LAN terminal devices connected to the wireless LAN
access points 16-i.

20  It is also possible to execute the above-
mentioned processes automatically by using control
programs.  That is to say, it is possible to calibrate
automatically (and periodically) a clock which belongs
to each of a plurality of terminal devices over a
25  wireless communication network.

The time-data with high accuracy is delivered to
each wireless LAN terminal device 17-j periodically in

an appropriate time interval.  Therefore, each
wireless LAN terminal device 17-j can keep its clock
accurate at any time.  Moreover, it becomes possible
not only to synchronize a clock of a wireless LAN

5      terminal device 17-j with a clock of a wireless LAN
access point 16-i but also to easily synchronize
clocks of a plurality of wireless LAN terminal devices
17-j to which the time-data is transmitted by the same
wireless LAN access point 16-i with each other.

10        In the above embodiment of the present invention,
the clock of each wireless LAN terminal devices 17-j
is calibrated by the time-data delivered through a
wireless LAN access point 16-i.  Here, it is also
possible to receive the time-data directly from the

15     wireless LAN terminal device 14 (GPS-based terminal
device 10) without the wireless LAN access point 16-i
by using pier-to-pier communication.  In that case,
the Steps S06 to S11 can be omitted from the
communication processes.

20        The GPS-based terminal device 10 can be provided
within any of the plurality of wireless LAN access
points 16-i.  In that case, the Steps S05 to S11 can
be omitted from the communication processes, resulting
in a prompt generation of the intermediate time-data

25     34 from the first time-data 33.

       The GPS receiver 12 can be provided within the
wireless LAN terminal device 14, i.e., the GPS-based

terminal device 10 can have an integrated structure.
In that case, the treatment of the GPS-based terminal
device 10 becomes easier. Also, the GPS receiver 12
can be provided independently of the GPS-based
5   terminal device 10. In that case, one terminal device
to be connected to the GPS receiver 12 is selected
from a plurality of terminal devices.

Instead of the first time-data 33, the time-data
of the clock 45 calibrated based on the first time-
10  data 33 can be transmitted from the wireless LAN
terminal device 14 to a wireless LAN access point 16-i.
Similarly, instead of the intermediate time-data 34,
the time-data of the clock 55 calibrated based on the
intermediate time-data 34 can be transmitted from a
15  wireless LAN access point 16-i to a wireless LAN
terminal device 17-j. Also in those cases, the same
result as in the case mentioned above can be obtained.

According to the present invention, as described
above, a user of a wireless LAN terminal device with a
20  GPS receiver can correct the clock of the own wireless
LAN terminal device by receiving satellite time-data
from GPS satellites. Furthermore, a user of a
wireless LAN terminal device without a GPS receiver
can correct the clock of the own wireless LAN terminal
25  device by receiving time-data from a user of a
wireless LAN terminal device having a GPS receiver
without mounting a GPS receiver on the own wireless

LAN terminal device.

It will be obvious to one skilled in the art that the present invention may be practiced in other embodiments that depart from the above-described 5 specific details.  The scope of the present invention, therefore, should be determined by the following claims.